The Rapidly Evolving Science of Coastal Blue Carbon: What's Known and What Do We Want to Know

> Stephen Crooks Ph.D. ESA PWA

Blue Carbon, Green Opportunities



Society of Wetlands Scientists / INTECOL June 6th 2012, Orlando, Florida



Esa PWA Ecosystems in focus for climate change mitigation

Forest



Peatland



Mangroves



Tidal Marshes



Seagrass



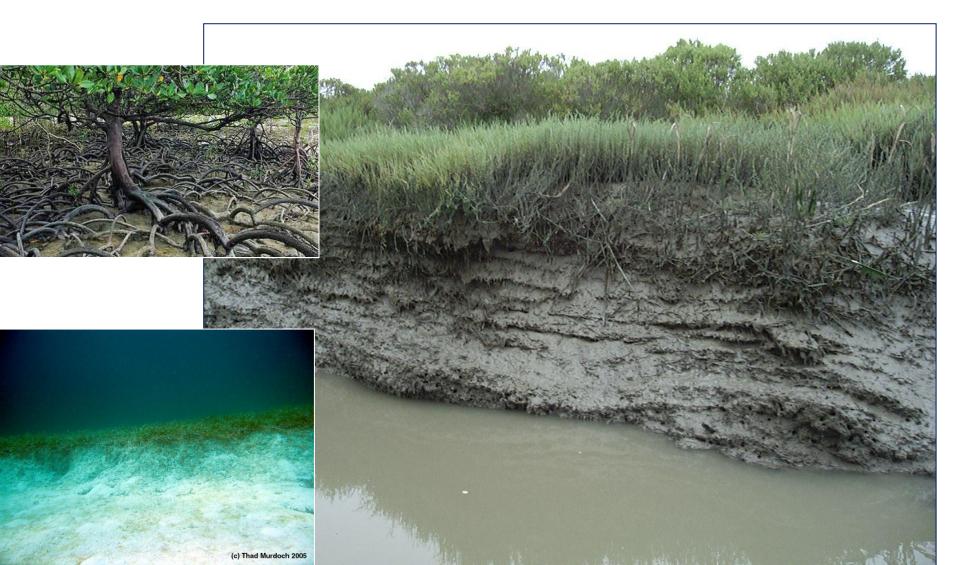
ESA PWA

Blue Carbon: Emissions, Economics and Policy



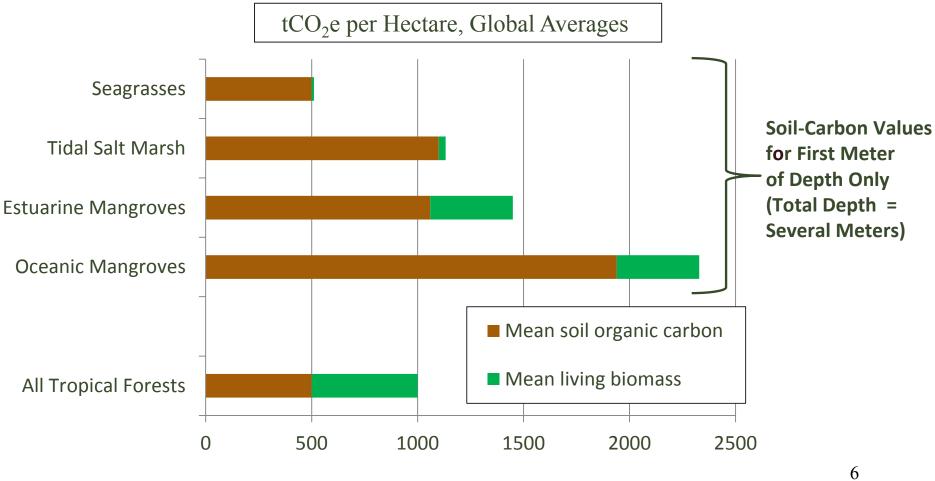
http://estuaries.org/climate-change.html

ESA PWA Coastal ecosystems: long-term carbon sequestration and storage





Distribution of carbon in coastal ecosystems



Data summarized in Crooks et al., 2011; Murray et al., 2011, Donato et al., 2011

Photo by Cath Lovelock

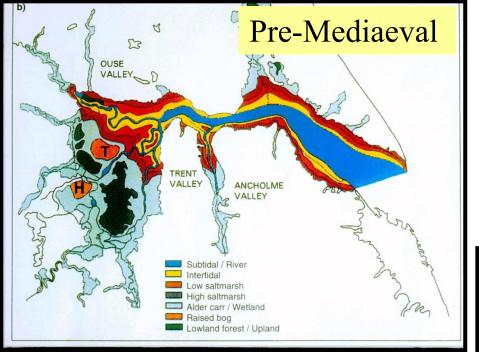
homen 2 march & Bridger

Rates of Wetland Loss

Ecosystem	Global Extent (km²)	Annual Rate Of Loss (%)	Total Stock (top meter) Pg C	Reference (stock estimates)
Tidal Marsh	400,000?	1 - 2	?	
Mangrove	160,000	1 - 2	14.7 - 73.0	Donato et al 2011
Seagrass	300- 600,000?	1 - 2	15.4 - 30.8	Fourqurean et al. 2012
1	Contraction of the second	A sure of the second		11 181 - THE PARTY OF THE PARTY

Estimate of global emissions $0.15 - 1.0 \text{ Pg CO}_2 / \text{yr}$ (Pentleton et al. in press)

ESA PWA Progressive change of our coastlines

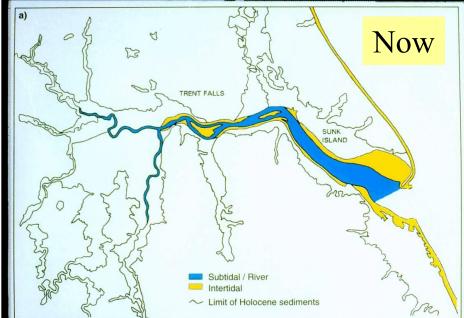


405 km of levees 870 km² of drained wetlands

C deposition >99% decrease Release of historic carbon Andrews et al., 2000, 2006

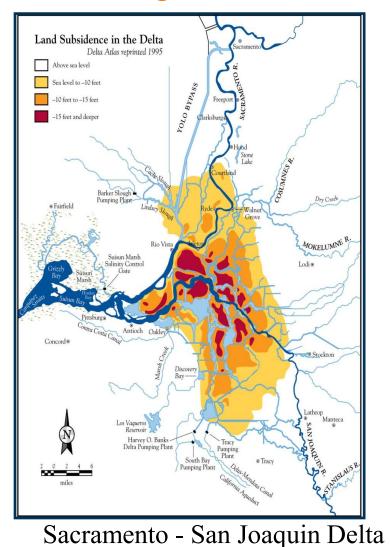
The Humber Estuary

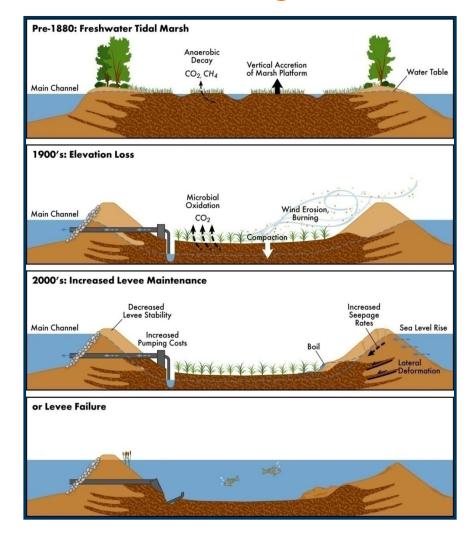
Extensive diked wetlands Post industrial estuary Agricultural run-off





Long-term release of carbon from organic soils





Emissions from One Drained Wetland: Sacramento-San Joaquin Delta



Area under agriculture 180,000 ha

Rate of subsidence (in) 1 inch

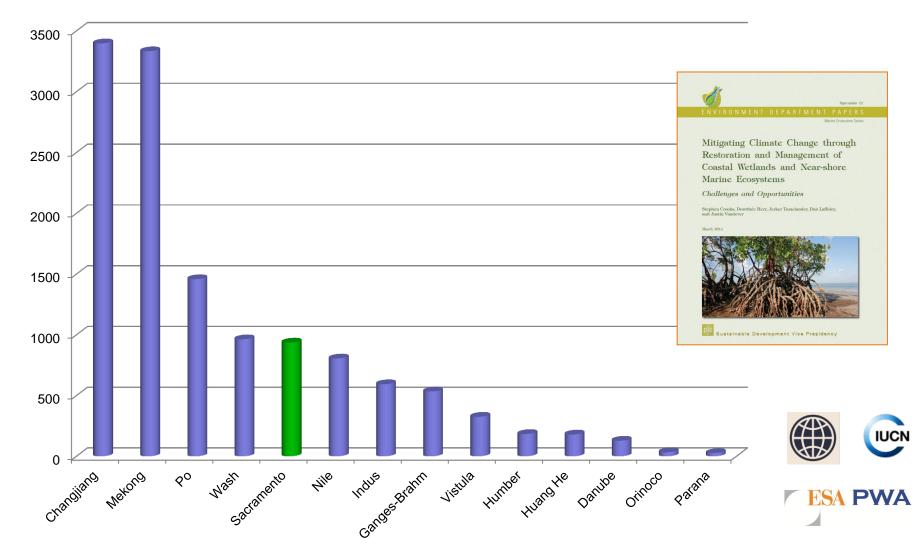
5 million tCO_2/yr released from Delta

1 GtCO₂ release in c.150 years 4000 years of carbon emitted Equiv. carbon held in 25% of California's forests

Accommodation space: 3 billion m³

CO₂ Emissions from drained coastal wetlands (million tons)

ESA PWA





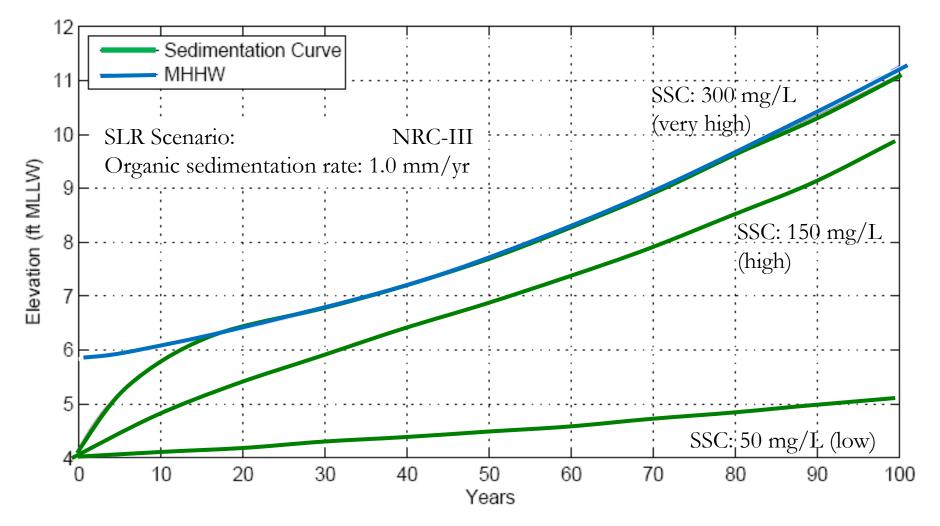
Emissions from drained wetlands organic soils

Ecosystem	Modification	CO2 efflux t/ ha / a	Method	Reference
Mangrove (Belize)	Cleared	29	CO2 efflux	Lovelock et al. 2011
Mangrove (Honduras)	Forest damaged by hurricane	15	Inferred from peat collapse	Cahoon et al. 2003
Mangrove (Australia)	Drained for agriculture	32	Peat collapse and CO2 efflux	Couwenburg et al. 2010
FWT marsh (California)	Drained for agriculture	6-40	Peat collapse and CO2 efflux	Rojstaczer & Deverel 1993; Deverel & Leighton 2010; Hatala et al. 2011
FWT marsh (Po Delta)	Drained for agriculture	92 ± 55	Peat collapse and CO2 efflux	Camporese et al. 2008; Zanello et al.2011



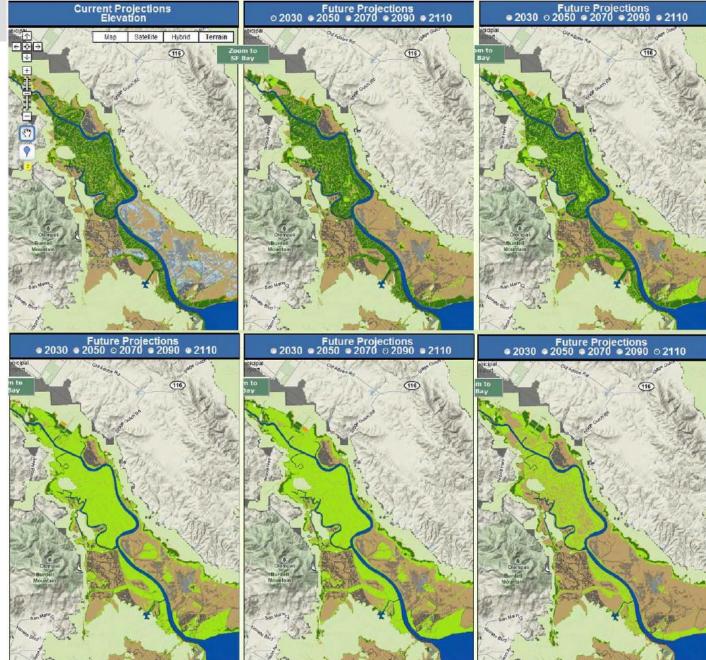
What about remaining wetlands?

ESA PWA Low Marsh Response to SLR for Ranging Sediment Availability



Modeled with Marsh98





Stralsburg et al. 2011

Large-scale Emissions, or not?

Wetland loss: 100 km² /yr

If top 50 cm erodes then 27.5TgCO₂ Released in to circulation

But what is its fate???

South Projected Land Loss in the Deltaic Plain

Lake Pontchartrain New Orleans Borgne Land Loss 1932- 205 Breton Sound Terrebonne Gulf of Mexico Bar 15 22.5 30



Coastal Louisiana has lost an average of 34 square miles of land, primarily marsh, per year for the last 50 years. From 1932 to 2000, coastal Louisiana lost 1,900 square miles of land, roughly an area the size of the state of Delaware. If nothing more is done to stop this land loss, Louisiana could potentially lose approximately 700 additional square miles of land, or an area about equal to the size of the greater Washington D.C.- Baltimore area, in the next 50 years.

For more information about the land loss analysis or to see an animated time series of wetland change, visit www.LaCoast.gov/LandLoss



Data Sources: 1932-1956 Land Change Analysis U.S. Army Corps of Engineers, New Orlean

> 6-1990 Land Change Analysis 8-2050 Land Change Analysis . Department of the Interior . Geological Survey onal Wetlands Research Center wette, LA

epared by: S. Department of the Interior S. Geological Survey ational Wetlands Research Center fayette. LA

Map ID: USGS-NWRC 2005-16-0001 Map Date: December 6, 2004



Information needs - quantification

- CO₂, CH₄ and N₂O fluxes in wetlands across salinity gradients and under ranging conditions of nitrogen loading.
- GHG fluxes for undisturbed, <u>converted</u> and restoring wetlands
- Wetland carbon stocks better global coverage
- Fate of C & N released from eroding wetlands
- Contribution of DOC to global warming



Information needs - models

- GHG emissions / reductions with landscape change wetland migration, conversion.
- Process-based models to understand science of C&N cycling (e.g. DNDC)
- Simplified monitoring approaches / indicators
- Default factors of emissions and removals with activities.



Information needs - mapping

Intact and degraded salt marsh and seagrasses

Subclasses of coastal wetlands (can we connect to cover to geomorphology and below ground processes?)

Drained wetlands, soil classification (C%)



Information needs - technology

Near surface atmospheric GHG monitoring

High resolution surface elevation mapping

Less costly monitoring equipment

Stephen Crooks Director Climate Change Services ESA PWA +1 415 272 3916 <u>SCrooks@esassoc.com</u>